

# New Views of EIT Wave and CME from STEREO

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## ABSTRACT

On 2007 December 7, a small filament located in a small active region AR 10977 erupted and led to a B1.4 flare. An EIT wave associated with this eruption was observed both by SOHO/EIT and by EUVI on board STEREO. According to the observations from SOHO/LASCO and STEREO/COR A, we found that there was no CME associated with the EIT wave. This seems to challenge the argument that the cause of EIT waves is CME. However the data from STEREO/COR B indicated that there was a narrow CME associated with the EIT wave. This suggests that studying CMEs by investigating observations made in one direction alone may not be able to guarantee the reliability of the results.

**Key words:** Sun: EIT waves, Sun: CMEs

## 1 INTRODUCTION

Usually, EIT waves appear as almost circular diffuse emission enhancements propagating across the whole solar disk immediately followed by an expanding dimming region if the magnetic structure on the Sun is simple with only one active region on the disk (Thompson et al. 1998). While, when the global magnetic structure gets complicated, they propagate rather inhomogeneously, avoiding strong magnetic features and neutral lines and generally stopping near coronal holes (Thompson et al. 1999). Although EIT waves were found to be a quite frequent phenomenon, there are still some questions open. The cause of the EIT wave is still being debated between a “flare-driven” and a “CME-driven” (Uchida 1968; Warmuth et al. 2001; Warmuth et al. 2004; Biesecker et al. 2002; Hudson et al. 2003; Zhukov & Auchère 2004; Cliver et al. 2005; Vršnak et al. 2006). The launch of the Solar Terrestrial Relation Observatory (STEREO) (Kaiser et al. 2008) provides us an opportunity to find the answer.

## 2 INSTRUMENTS AND OBSERVATIONS

In this work we use the data from extreme ultraviolet imager (EUVI), part of the Sun Earth Connection Coronal and Heliospheric Investigation(SECCHI) (Howard et al. 2008) on board STEREO, which consists of two identical spacecrafts that orbit the Sun ahead (STEREO A) and behind (STEREO B) the Earth near the ecliptic plane. Their separation angle was 42.4° on 2007 December 7. EUVI images

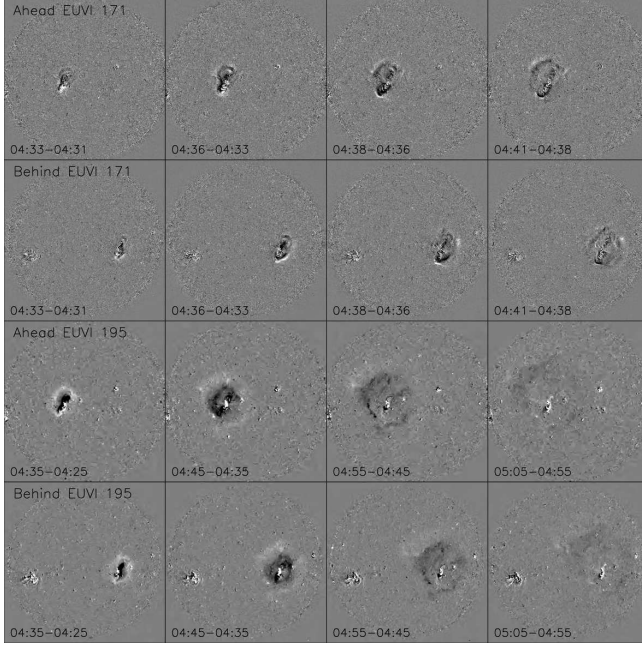
the solar chromosphere and the low corona in four emission lines, 171 Å, 195 Å, 284 Å and 304 Å, out to 1.7 R<sub>⊙</sub>. The pixel limited spatial resolution of EUVI images is 1.6″. In this research we focus on the EUVI images in 171 Å and 195 Å with a time cadence of 2.5 and 10 minutes respectively.

COR1 is a classic Lyot internally occulting refractive coronagraph. It images the inner corona with the pixel spatial resolution of 3.75″ from 1.4 to 4 R<sub>⊙</sub> and the image sequence cadence is 8 minutes. COR1 measures both the total brightness B and the polarized brightness pB of the solar K corona. In this paper we use the total brightness B. COR2 is an outer coronagraph imaging the outer corona with the pixel spatial resolution of 14.7″ and the image sequence cadence is 15 minutes from 2.5 to 15 R<sub>⊙</sub>. The COR2 instruments acquires only polarized images of the corona since the polarizer is always in the beam. The total brightness B is used here.

## 3 RESULTS

The EIT wave we studied occurred on 2007 December 7 during 4:25-5:10 UT, associated with the weak B1.4 class flare as well as the eruptions of a filament and a sigmoid located in NOAA active region AR 10977. On that day STEREO A was 20.8° ahead the Earth at a heliocentric distance of 0.97 AU and STEREO B was 21.6° behind at 1.03AU.

The EIT wave showed a weak front in EUVI 171 Å running difference images (the top two rows of Figure 1) and a strong front in EUVI 195 Å ones (the bottom two rows of



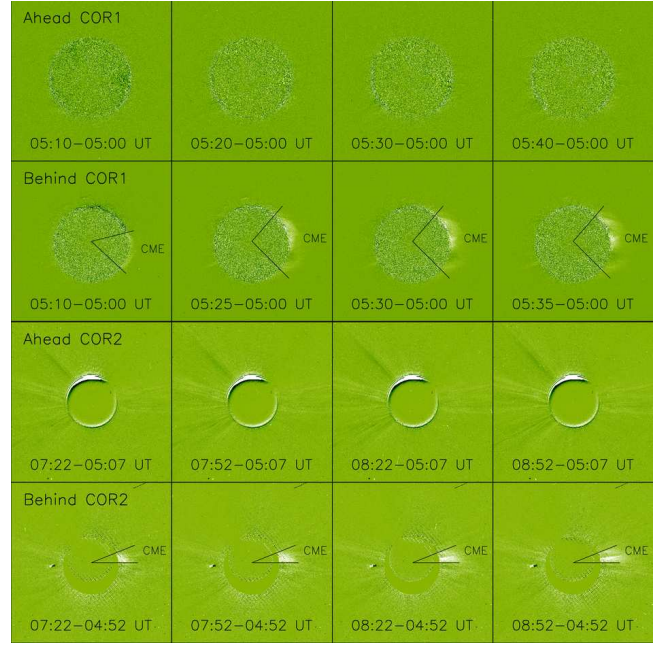
**Figure 1.** EUVI running difference images showing the propagation of the EIT wave. The top two rows for Ahead and Behind EUVI 171 Å images and the bottom two rows for Ahead and Behind EUVI 195 Å images.

Figure 1). The wave front of the EIT wave appeared different shapes in EUVI A and B especially at the beginning of the EIT wave (see the panels before 04:40 UT): the EIT wave looked like a right ear in EUVI A and a left ear in EUVI B images. This indicates that the propagation of the EIT wave at the beginning was not symmetric about the center. However with the time progressing the EIT front became more and more symmetric (see the panels after 04:40 UT).

Figure 2 displays the STEREO COR1 and COR2 white light images showing the inner and outer corona intensity changes. It is very interesting to notice that STEREO B observed the CME associated with the EIT wave in both COR1 and COR2 FOVs, while STEREO A did not. Nor did SOHO/LASCO. The second and the bottom rows display the evolution of the CME. COR1 B showed that when the CME appeared on the limb, its angular width is about  $50^\circ$ . Then its angular width increased to about  $90^\circ$ . However, the angular width of the same CME in COR2 images was about  $28^\circ$  remained roughly unchanged.

#### 4 CONCLUSIONS AND DISCUSSIONS

In this paper we displayed an observation of an EIT wave and the associated CME in two directions simultaneously by STEREO A and B. We found no CME associated with the EIT wave in the STEREO A data, however a contrary result was obtained from STEREO B. Comparing the data from STEREO A and that from STEREO B, we realized that the CME was very narrow and roughly propagated toward STEREO A. So it was almost totally blocked by the occulting disk of STEREO A at the beginning, and it became too faint to be observed as its angular width got large enough. This work reminds us of a preview work by Thomp-



**Figure 2.** STEREO COR1 (top two rows) and COR2 (bottom two rows) different images displaying the CME.

son (2000) that reported an EIT wave without clear evidence of a CME and suggested that some EIT waves may be CME-poor. However, the present work indicates whether a CME is observed to associate with an EIT wave depends on the angle at which it is seen and on its brightness.

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